

Amendments to the Drawings:

The drawing sheet attached in connection with the above-identified application containing Figures 2-4 is being presented as a new formal drawing sheet to be substituted for the previously submitted drawing sheet. The drawing Figures 2 and 3 have been amended. Appended to this amendment is an annotated copy of the previous drawing sheet which has been marked to show changes presented in the replacement sheet of the drawing.

The specific changes which have been made to Figures 2 and 3 is cross hatching of the parts shown.

REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

Claim Rejections – 35 USC 103

The claims stand rejected as being obvious over Yamamoto et al. in light of Tomiyama et al.

Yamamoto et al. is cited as an example of a multilayered circuit board in which the interlayer connection is made through minute protrusions. Though Yamamoto uses a thermoplastic film, the Examiner recognizes that Yamamoto does not disclose a three-layered insulating material as described in the claimed invention. In column 6, lines 37-39, Yamamoto says that the film thickness is preferably between 50 to 800 μm which is a greatly different range from the claimed invention's range of 25 μm or less. The use of a layer of a conventional single film of this thickness or the use of a prepreg consisting of a single layer resin film and a glass cloth, etc. cannot solve the problem at issue, and the claimed invention was made in order to comprehensively solve problems associated with the manufacturing of multilayered circuit boards.

The claimed invention comprises a three-layered insulating adhesive film consisting of a thermosetting adhesive layer, a thermoplastic film and a thermosetting adhesive layer in which minute protrusions connect layers of a multilayered circuit board during manufacturing. In particular, the main feature of the invention is that the structure of the three-layered insulating material comprises a thermosetting adhesive with a thickness greater than the opposing copper layer, a thermoplastic layer with a width of 25 μm or less and a thermosetting adhesive with a thickness greater than the opposing copper layer. With this structure, the conductive protrusions can stably pass through the insulating material and the process is cost efficient. The multilayer circuit boards can be connected through the minute conductive projections stably and at a low cost.

Tomiyama does not remedy the deficiencies of Yamamoto. The three-layered adhesive of Tomiyama et al. is used to adhere semiconductors to circuit boards. The three-layered insulating film is used on the surface of circuit boards as an adhesive between the semiconductors and the board.

In contrast, the three-layered insulating film of the claimed invention is an interlayer adhesive material serving as a constituent feature of a multilayered circuit board and existing within the circuit boards. The problem to be solved in Tomiyama is to prevent voids at the adhesion interface and excessive protrusions. Since the point is to adhere semiconductors to circuit boards, there is absolutely no connection with interlayer conduction methods within circuit boards, nor are these problems ever suggested in Tomiyama.

The core film of the three-layered adhesive mentioned in the embodiment of Tomiyama is a 25 μm UPLEX film from Ube Industries Ltd. This UPLEX film is a rather hard polyimide film. In manufacturing the multilayered circuit board of the claimed invention using conductive protrusions to connect the layers, the minute conductive protrusions would be unable to protrude through the 25 μm UPLEX film. This film would not be preferable because the conductive protrusions themselves would break.

The three-layered insulating film of the present invention is advantageous in connecting layers of a multilayered circuit board using conductive protrusions because of its high manufacturing yield. The three-layered insulating film of the present invention is a constituent feature of the multilayered circuit board and is composed of a thermoplastic film inserted between a pair of thermosetting adhesive layers. In some embodiments, the core film is a thin 10 μm thermoplastic liquid crystal polymer film with 40 μm thermosetting resin layers on either side.

The present invention achieves the multiple advantages as explained below, and the structure and thickness are simply to prevent voids, as the Examiner argues. The features and advantages of the present invention are as follows:

In order to manufacture multilayered circuit boards using minute protrusions to connect the layers, high yield and low cost can only be achieved if the minute conductive protrusions stably protrude through the interlayer insulating resin.

The invention utilizes a thin thermoplastic core film which becomes softer as the temperature increases, allowing the minute conductive protrusions to pass through easily.

The strength of the film is decreased by reducing its thickness, and in addition there are no hard compounds like glass cloth. This enables the film to be easily penetrated, and a simple and low-cost vacuum press can be used to press the boards even when the protrusions are minute. This also negates the need to preprocess the interlayer insulating resin to create holes with a laser or NC drill, resulting in a significantly improved. Moreover, there is relatively little dust contamination in this process, and therefore the process can successfully reduce the amount of manufacturing problems caused by contaminants to ensure a stable manufacturing process.

When multilayered circuit boards are involved, there should be electrical insulation between each layer of circuit board.

In general, the manufacturing of multilayered circuit boards requires that the press process be repeated many times. In addition, it is common that the insulator sandwiched between the layers of circuit board is made of a prepreg material composed of a glass cloth impregnated with a thermosetting resin. The reason for using the prepreg is that the form of the thermosetting resin can easily change before it hardens. The conductor between the layers could short because the thermosetting resin alone would be crushed under the pressure of the press. The glass cloth is added to prevent the thermosetting resin from being crushed. However, the glass cloth is typically uneven in form and hard in structure, and therefore it creates an obstacle to conduction between the layers using minute conductive protrusions. On the other hand, it is not possible to use the thermosetting resin as an insulator alone, without a glass cloth between the circuit board layers. As mentioned previously, the thermosetting resin will soften before hardening and easily flow out during heat press, raising the danger of short-circuit of the conductors.

In the present three-layered insulating material, the thermoplastic film used as the core insulating film maintains its form during the press process and can maintain electric insulation between the layers. In addition, as the thermoplastic film is thin, the minute conductive protrusions can easily pass through and connect the circuit boards.

In the case of multilayered circuit boards, insulating resin must be adequately provided between the conductor material to maintain stable electrical and physical properties.

In the three-layered interlayer insulating material of claimed invention, the thin thermoplastic film is sandwiched by thermosetting resin layers with a thickness greater than

the opposing conducting layers when the layers are stacked, which makes it possible to easily provide sufficient insulating resin between the conductors.

The claimed invention is necessary for connecting multilayered circuit boards with minute conductive protrusions, and has nothing to do with the invention of Tomiyama in which semiconductors are attached to the surface of circuit boards.

Conclusion

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date July 6, 2005

By _____

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FIG. 2

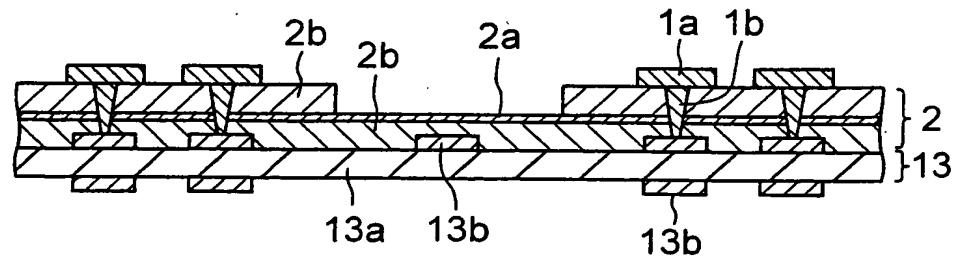


FIG. 3

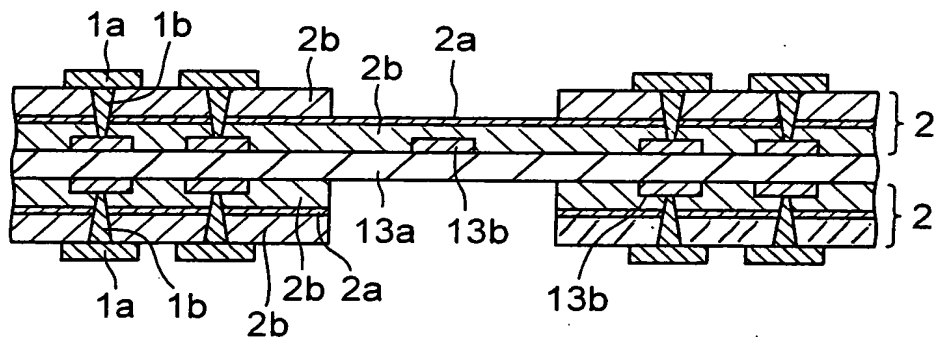


FIG. 4

